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Approved For Release 2002/01/02 : CIA-RDP78B04747A002600010025-6

NFIC/P&DS/D/6-1347
4 May 1966

MEMORANDUM FOR THE RECORD

SUBJECT: Acceptance Inspection of the [REDACTED] Change Detector

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1. The Change Detector, developed under Contract [REDACTED] was delivered to the Center on 2 October 1964. This delivery date was met by postponing a number of delicate adjustments which should have been made at the factory, on the grounds that they would be disturbed in transit. When these adjustments were made by factory personnel after delivery, they caused other maladjustments.

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2. [REDACTED] personnel worked on the equipment until 15 May 1965 and corrected all faults except the signal-to-noise ratio and the cloud and shadow rejection circuits. These deficiencies are related to a power amplifier which is too weak (having been designed for a smaller film gate). A heavier power amplifier will be installed under the current maintenance contract and the above faults will be corrected at that time.

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3. Attached are three sets of test documents:

- a. An outline of the Test Plan, which was followed with only minor exceptions.
- b. A report of preliminary tests made at the factory before delivery of the equipment.
- c. A report of tests made after equipment was installed and checked out at the destination.

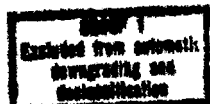
4. There are a number of areas in which the design goals have not been met. Some of these are due to directed design changes (such as CRT rotation) and are documented as Engineering Changes in the contract; other are the result of changes in adjustments to obtain better control of certain movements.

5. The Change Detector provides a convenient method for the manipulation, super-imposition, and registration of a pair of images. The attainable resolution is, however, below the specified design goal of 50 line pairs/mm and causes a loss of information from extremely high resolution material. This unsatisfactory resolution is due in part to the poor signal-to-noise ratio now introduced in the instrument and to

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the necessary misplacement of the focusing coil on the CRT, which was moved to provide space for the CRT rotation drive. It is recommended that a replacement CRT with a special focusing coil be installed to correct this deficiency in resolution. The installation of a heavier power amplifier, now on hand at [REDACTED] will also aid in increasing resolution. Both of these actions can be accomplished under the existing maintenance contract.

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6. After the above deficiencies are corrected, the instrument should be thoroughly use-tested by operational photo interpreters to determine the validity of the change detection principle and to justify follow-on efforts in this area.

[REDACTED]

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Development Branch, SSS

Distribution:

Original - Project File/DB (#997153)

2 - [REDACTED]
2 - Chrono/DB
1 - [REDACTED]

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Attachments: As Stated

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Enclosure 1

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CHANGE DETECTOR TESTS -- Summary

<u>Item</u>	<u>Design Goal</u>
1. Resolution:	50 lines/mm at max. (40) magnification
2. Frame Counter Accuracy:	250 ft roll with 5.5" or over frames, <1 frame 250 ft roll with 2 $\frac{1}{4}$ " frames, <5 frames
3. Measurement Accuracy Within Frame:	$\frac{1}{4}$ mm (approx. 0.61")
4. Distortion:	Not specified
5. X-Y Movement:	Not specified
6. Orientation:	$\pm 90^\circ$ for each input film
7. Sensitivity:	Not specified
8. Signal/Noise Ratio:	Not specified
9. Shadow and Cloud Rejection:	Not specified
10. Correlation:	First frame: 2 minutes Succeeding frames: 30 seconds
11. Durability:	Not specified
12. Tip and Tilt Adjustments:	Tip : $\pm 5^\circ$ along flight line Tilt : $\pm 5^\circ$ laterally
13. Film Transport:	Slow range: 0 to 0.2 IPS (1.0 FPM) Fast range: 0 to 24 IPS (120 FPM)
14. Scale Adjustment:	Ratio between images of not more than 2:1
15. Optics:	Not Specified
16. Human Engineering:	Not specified.
17. Magnification	Min. 5X Max. 200Y

TESTS FOR CHANGE DETECTOR

1. RESOLUTION ✓
2. FRAME COUNTER ACCURACY ✓
3. MEASUREMENT ACCURACY WITHIN FRAME ✓
4. DISTORTION ✓
5. X-Y MOVEMENT
6. ORIENTATION ✓
7. SENSITIVITY
8. SIGNAL/NOISE RATIO
9. SHADOW AND CLOUD REJECTION
10. CORRELATION (Image Matching)
11. DURABILITY
12. TIP AND TILT ADJUSTMENTS
13. FLIGHT TRANSPORT ✓
14. SCALE ADJUSTMENT
15. OPTICS
16. HUMAN ENGINEERING
17. MAGNIFICATION

1. RESOLUTION

A. Design Goal: 50 lines/mm at maximum magnification.

B. Method of Measurement: Use the USAF 1951 resolution pattern and measure resolution on the screen at maximum magnification and at normal magnification. Obtain resolution at 13 positions. Record all significant dial settings. Measurements will be made separately by three people. Each will record at least three readings at each position. Repeatability is important.

C. Required Imagery: Standard USAF 1951 resolution pattern on film, the small portion of the pattern at 13 positions on a 70 mm format.

2. FRAME COUNTER ACCURACY

A. Design Goal: For 250-foot roll with frame length over 5.5 inches, error less than 1 frame. For 250-foot roll with frame length of 2-1/4 inches, maximum error of 5 frames at end of roll.

B. Method of Measurement: The above limitations are based on a maximum error of .01 inch in the measurement of frame lengths.

- (1) Set in the distance from frame to frame.
- (2) Run a roll of film through the Change Detector, counting the frames. Do this three times for each format size.
- (3) Compare frame counter total with actual number of frames in the roll.
- (4) Repeat this procedure for several format sizes.

C. Imagery Required: 250-foot roll of film with frames evenly spaced throughout the roll, square format and about 6-inch panoramic size. (100-foot rolls could be used. Error should probably be expressed per 100-foot of film).

3. MEASUREMENT ACCURACY WITHIN FRAME

A. Design Goal: 1/4 mm (approx. .01 inch)

B. Method of Measurement: Measure distance between two points on a frame on the film using the cross-hairs in the Change Detector. Do this for points within the normal square format size and also on a long frame where the film must be moved across the aperture to get from the first point to the second. Compare these measurements with those taken by another method of known high accuracy. Take at least three measurements for each distance checked.

C. Imagery Required: Square grid pattern will be convenient to use.

4. DISTORTION

A. Design Goal: Not specific.

B. Method of Measurement: Put a square grid pattern into the aperture and display it on the monitor. The screen can be photographed from the greatest distance practical to minimize distortions caused by the curved surface of the screen. Square grid pattern will also be photographed for comparison and to check any camera distortions. Also take measurements off the screen to check distortion. Comparative distortion between the two channels is important. Put grid pattern in each aperture and show on screen simultaneously to check differential distortion. These presentations can be photographed and also measured on the screen. Measurements should be made horizontally and vertically across the screen and the geometric shape should be checked three times. Any distortions should be consistent in each channel.

C. Imagery Required: Square grid pattern.

5. X-Y MOVEMENT

A. Design Goal: Not specific.

B. Method of Measurement: Using comparative cover which is centered over different points, check if X and Y movements are made properly.

C. Imagery Required: Almost any comparative cover aerial photography will be satisfactory for this.

6. ORIENTATION

A. Design Goal: $\pm 90^\circ$ for each input film.

B. Method of Measurement: Films of the same area, oriented in different directions, will be placed in the two apertures. Since the image in each channel can be optically rotated $\pm 90^\circ$, correlation should be accomplished for any possible differences in orientation of the film. There are no specific measurements to make. Try it using 3 or 4 different orientations of film, including orientation in almost the opposite directions.

7. SENSITIVITY

A. Design Goal: Not specified.

B. Method of Measurement: Measure the sensitivity of the Change Detector to small differences in gray levels. Two or three gray scales will be copied on transparencies. Densitometer values will be measured for each gray level. Each scale can be correlated with a duplicate of the same scale and will indicate no changes. Scales can be shifted manually so one gray level is overlaying another gray level. This should show as a change if the sensitivity to small differences in film density is sufficient. Density values for these observations will be recorded. Four different one-step differences from light to darker densities will be checked.

C. Imagery required: Gray scales on film.

8. SIGNAL/NOISE RATIO

A. Design Goal: Not specified

B. Method of Measurement: Use oscilloscope to measure the amplitude of the video signal. Measure amplitude of both the signal and the noise, peak to peak. Compute the ratio:

$$\frac{\text{Signal (volts)}}{\text{Noise (volts)}}$$

This ratio will vary with the area of imagery covered; entire area will give better ratio than small area will. Obtain S/N for several areas and plot on curve: S/N vs. area. (Film with high base density will give more noise.) Ratio will vary with the contrast. To standardize, use block pattern; ratio is highest then. Measure the value five times.

C. Imagery Required: Black on white test pattern.

Comment: There are several methods of measuring S/N ratio. The value can vary considerably depending on the method, contrast, base density. S/N measured by RMS (root mean square) method is about 2.8 times the S/N obtained by the peak-to-peak method.

9. SHADOW AND CLOUD REJECTION.

A. Design Goal: Not specific.

B. Method of Measurement:

(1) Rejection of shadow and cloud differences being displayed as changes is generally desirable as these differences are usually not significant. Circuitry has been incorporated to "clip" any changes darker than a certain level for shadows or brighter than a certain level for clouds. Shadows are generally the darkest parts of an airphoto, although this is not always true.

(2) Put comparative cover with shadow differences into the apertures. Display the changes without any clipping. Then adjust clipping level so shadow differences are eliminated. Check on the effect this has on other changes.

(3) Check this using "average" photography where the ground features are not very dark and also where very dark features are present, such as irrigated fields in arid areas at certain times of the year.

(4) Also put comparative cover with clouds on one set into the apertures. Display the changes without any clipping. Then adjust clipping level so the "white" cloud differences are eliminated. Check on the effect this has on other changes.

(5) There are no specific measurements to make. Check if the clipping procedure is effective. It is realized that extremely dark on light objects will also be affected by the clipping process.

C. Imagery Required:

(1) Comparative cover with "normal" range of gray scales, no extremes.

(2) Comparative cover with some extremely dark field patterns such as irrigated fields in arid areas at certain times of the year.

10. CORRELATION

A. Design Goal:

- (1) 2 minutes for first frame (maximum).
- (2) 30 seconds per frame (worst case) after first frame.

B. Method of Measurement: Put comparative cover into Change Detector. Initial approximate alignment is performed manually, while viewing the two scenes on the monitors. Tilt and focus adjustments must be made. Then final correlation can be made automatically. On the following frames, alignment will probably be close enough so these manual steps will not be necessary. Measure the time required to make the initial orientation and correlation and also check the subsequent frames without the initial manual alignment that is generally required on the first frame. Time required for correlation may vary with degree, the differences in the two sets of imagery, such^{as} seasonal changes, differences in positions of cameras, amount of overlap, and tip and tilt settings. Such differences will be recorded for each test. Time should, however, consistently be within the design goal. Check at least six times.

C. Imagery Required: Comparative cover of several sites with various relations of orientation, scale, and overlap.

11. DURABILITY

A. Design Goal: It is desired that the Change Detector be able to operate continuously for a considerable period of time, for an hour shift at least.

B. Method of Measurement:

(1) Records will be kept on the operation of the Change Detector during the training and testing programs. Keep the Change Detector operating for 8 hours for two days during this time. Time of operation to failure of any component will be recorded.

(2) Obtain from [REDACTED] or the manufacturer what the expected life of the CRT is. Obtain the normal characteristics of the CRT and the effect on its life if it is operated continuously or intermittently.

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C. Imagery Required: Any rolls of comparative cover.

12. TIP AND TILT ADJUSTMENTS

A. Design Goal

Tip - $\pm 5^\circ$ along flight line

Tilt - $\pm 5^\circ$ laterally

B. Method of Measurement

(1) Check to make sure this manual control works properly in all four directions.

(2) Measure the angle when the movement is at its maximum in the four directions.

(3) Check the effect of tip and tilt on correlation and on the change display.

C. Imagery Required: Test pattern with photo taken vertically and at 2, 5, and 10 degrees from the vertical.

15. FILM TRANSPORT

A. Design Goal, two speed ranges:

0 to .2 in/sec (1.0 ft/min)

0 to 24 in/sec (120 ft/min)

B. Method of Testing:

(1) Slow Range - Run 10 feet of film at maximum speed, should take 10 minutes.

(2) Fast Range - Run 120 feet of film at maximum speed, should take 1 minute.

(3) Results should be fairly consistent. Measure each speed three times.

C. Required Imagery: 120 foot roll of film (minimum). No special imagery is required, only a known length of film.

NOTE: Also check for any damage to the film, such as scratches or nicks in the edges.

14. SCALE ADJUSTMENT

A. Design Goal: Images can be correlated if scale of one film is 2 times the scale on the other.

B. Method of Measurement: Place comparative cover which has different scales in the apertures and correlate the images. Set approximate scale adjustment manually and make final correlation automatically. Do this five times with different scale factors from 1.0 to 2.0 between the coverages.

C. Imagery Required:

- (1) Test pattern at several different scales
- (2) Aerial photographic coverage of a site at several different scales.

15. OPTICS

A. Design Goal: Not Specific

(Resolution of image on the screen is to be 50 lines/mm at maximum magnification with respect to transparency. No specific figures for the optics alone.)

B. Method of Measurement

(1) The resolution of the optics can be measured between each film and the CRT scanner. Resolution pattern will be placed in film plane, and a microscope properly positioned and focussed at the CRT. The resolution will be read through the microscope. This will be done for each channel. Measure at least three times. Values should be consistent.

(2) Specifications for the lenses will be obtained from [REDACTED]
The objective lenses are commercial lenses; the condensing lenses were made to order.

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C. Imagery Required: Resolution pattern.

16. HUMAN ENGINEERING

A. Design Goals: Not specific.

B. Method of Measurement: During the testing and training periods, comments by those operating the Change Detector will be recorded, concerning the following human factors considerations:

(1) Control panel -- switches, knobs, locations, manner of operation, labeling.

(2) Ease of operation, visual comfort, physical comfort, noise, heat, glare.

(3) Safety conditions or hazards.

C. Imagery Required: Any comparative cover photography.